

**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY
OR PRIVILEGE ARE CLAIMED ARE DEFINED AS FOLLOWS:**

1 1. A computer program product comprising a computer usable medium tangibly
2 embodying computer readable program code means comprising a compiler and an associated
3 runtime helper, the runtime helper being defined for resolving references at runtime, the compiler
4 comprising means to emit compiled code including a set of target instructions, each target
5 instruction having an associated target location in the emitted compiled code and having an
6 unresolved reference at compile time, the emitted compiled code for each target instruction
7 comprising:

8 code means for directing the computer to define a trigger instruction
9 initially located at the associated target location in the emitted compiled code;

10 code means for directing the computer to define a snippet comprising a
11 copy of the target instruction including the unresolved reference and resolution
12 data useable by the runtime helper to resolve unresolved references in the target
13 instruction; and

14 the compiler further comprising code means for directing the computer to define
15 the trigger instruction to trigger the execution of defined instructions to pass data to the
16 runtime helper for resolution of the unresolved reference in the copy of the target
17 instruction and to replace the trigger instruction at the associated target location with the
18 copy of the target instruction having the unresolved reference resolved.

1 2. The computer program product of claim 1 in which the compiler further comprises:
2 code means for directing the computer to first emit, for each one of the set of target
3 instructions, the associated unresolved target instruction at the corresponding target location;
4 code means for directing the computer to create and maintain a snippet list comprising
5 entries, each entry in the snippet list corresponding to one of the set of target instructions;
6 code means for directing the computer to subsequently traverse the snippet list, and for
7 each entry in the snippet list defining the snippet relating to the one of the set of target
8 instructions corresponding to the snippet list entry; and
9 code means for directing the computer to store the associated unresolved target instruction
10 in the defined snippet to permit replacing of the associated unresolved target instruction at its
11 associated target location with the corresponding trigger instruction.

1 3. The computer program product of claim 1 in which the trigger instruction for a
2 one of the set of target instructions is a call to the corresponding snippet and in which the snippet
3 comprises instructions to pass the resolution data to the runtime helper.

1 4. The computer program product of claim 1 in which the trigger instruction for a
2 one of the set of target instructions comprises an illegal instruction for throwing an exception on
3 execution, and in which the computer program product further comprises program code means
4 comprising code means for directing the computer to define a trap handler comprising instructions
5 to branch to the snippet corresponding to the target instruction when the exception is thrown.

1 5. The computer program product of claim 4 in which the trap handler further
2 comprises a data structure for identifying snippets and in which the instructions to branch to the
3 snippet corresponding to the target instruction further comprise a look up in the data structure to
4 define the instructions to branch to the snippet corresponding to the target instruction.

1 6. The computer program product of claim 1 in which the compiler is a Java just in
2 time compiler.

1 7. A computer program product comprising a computer usable medium tangibly
2 embodying computer readable program code means for defining a Java runtime environment, said
3 computer readable program code means comprising a Java just in time compiler and an associated
4 runtime helper, the runtime helper being defined for resolving references at runtime, the compiler
5 comprising means to emit compiled code including a set of target instructions, each target
6 instruction having an associated target location in the emitted compiled code, each target
7 instruction including one or more unresolved references at compile time, the means to emit the
8 compiled code comprising:

9 code means for directing the computer to first emit, for each one of the set
10 of target instructions, an associated unresolved target instruction at the
11 corresponding target location;

code means for directing the computer to create and maintain a snippet list comprising entries, each entry in the snippet list corresponding to one of the set of target instructions;

code means for directing the computer to subsequently traverse the snippet list to emit compiled code, for each target instruction, comprising:

a snippet comprising instructions and data for calling the runtime helper to resolve the unresolved references in the target instruction at runtime, and comprising a copy of the target instruction including the unresolved references, and

a call instruction to the snippet, the call instruction being written to the target location in the emitted compiled code,

the runtime helper comprising instructions for a specified target instruction to resolve the unresolved references of the specified target instruction at runtime and for the specified target instruction, to replace the associated trigger instruction at a specified target location with the copy of the specified target instruction having the unresolved reference resolved.

8. A method of generating compiled code for an instruction having an unresolved compile-time reference, comprising the acts of:

specifying a runtime helper routine for resolving unresolved references at runtime;

5 emitting unresolved code in the generated compiled code comprising a
6 default reference value being a placeholder for an unresolved reference;

7 emitting a snippet comprising instructions and data to identify the
8 unresolved emitted code in the compiled code and to call and provide data to the
9 runtime helper routine to permit the unresolved reference to be resolved;

10 storing a copy of the emitted unresolved code in the snippet; and

11 replacing the unresolved emitted code in the compiled code with a call
12 instruction for calling the snippet, the runtime helper routine being defined to
13 resolve references at runtime with respect to the copy of the emitted unresolved
14 code in the snippet to define a resolved instruction and to replace the call
15 instruction for calling the snippet with the resolved instruction.

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1 11. A method for emitting compiled computer code to resolve references in a set of
2 target instructions, each target instruction to be executed at a target location in the compiled code,
3 each target instruction including an unresolved reference at compile time, the method comprising:

4 emitting a trigger instruction for each target instruction, the trigger
5 instruction being located at the target location in the compiled code; and

6 emitting a snippet for each target instruction comprising a copy of the
7 target instruction including the unresolved reference and resolution data useable
8 by a runtime helper,

9 each trigger instruction being defined to trigger the execution of defined
10 instructions to pass a specified set of resolution data to the runtime helper for
11 resolution of the unresolved reference in a specified copy of a target instruction
12 and to replace the trigger instruction at the target location with the specified copy
13 of the target instruction having the unresolved reference resolved.

14 12. The method of claim 11 further comprising:

15 first emitting, for each one of the set of target instructions, the associated unresolved target
16 instruction at the corresponding target location;

17 creating and maintaining a snippet list comprising entries, each entry in the snippet list
18 corresponding to one of the set of target instructions;

19 subsequently traversing the snippet list, and for each entry in the snippet list

20 defining the snippet in the compiled code relating to the one of the set of target
21 instructions corresponding to the snippet list entry; and

9 storing the associated unresolved target instruction in the defined snippet to permit the
10 replacement of the associated unresolved target instruction at the target location for the associated
11 unresolved target instruction with a corresponding trigger instruction.

1 13. The method of claim 11 in which the trigger instruction for a one of the set of
2 target instructions is a call to the corresponding snippet for the target instruction and in which
3 the corresponding snippet comprises instructions to pass data to the runtime helper.

1 14. The method of claim 11 in which the trigger instruction for a one of the set of
2 target instructions comprises an illegal instruction for throwing an exception on execution to
3 cause a branch to the corresponding snippet corresponding to the target instruction.

1 15. The method of claim 14 further comprising the step of carrying out a look up in
2 a data structure to define the branch to the corresponding snippet corresponding to the target
3 instruction, upon the exception being thrown.